UNITED STATES PATENT APPLICATION FOR

PROCESS KIT DESIGN FOR DEPOSITION CHAMBER

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PROCESS KIT DESIGN FOR DEPOSITION CHAMBER

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention generally relates to semiconductor substrate processing systems. More specifically, the present invention relates to a deposition chamber for a semiconductor substrate processing system.

Description of the Related Art

[0002] Integrated circuits (IC) are manufactured by forming discrete semiconductor devices on a surface of a semiconductor substrate. An example of such a substrate is a silicon (Si) or silicon dioxide (SiO_2) wafer. Semiconductor devices are oftentimes manufactured on very large scales where thousands of micro-electronic devices (e.g., transistors, capacitors, and the like) are formed on a single substrate.

[0003] To interconnect the devices on a substrate, a multi-level network of interconnect structures is formed. Material is deposited on the substrate in layers and selectively removed in a series of controlled steps. In this way, various conductive layers are interconnected to one another to facilitate propagation of electronic signals.

[0004] One manner of depositing films in the semiconductor industry is known as chemical vapor deposition, or "CVD." CVD may be used to deposit films of various kinds, including intrinsic and doped amorphous silicon, silicon oxide, silicon nitride, silicon oxynitride and the like. Semiconductor CVD processing is generally done in a vacuum chamber by heating precursor gases which dissociate and react to form the desired film. In order to deposit films at low temperatures and relatively high deposition rates, a plasma can be formed from the precursor gases in the chamber during deposition. Such processes are known as plasma enhanced chemical vapor deposition, or "PECVD."

[0005] Reliable formation of high aspect ratio features with desired critical dimensions requires precise patterning and subsequent etching of the substrate. A technique sometimes used to form more precise patterns on substrates is photolithography. The technique generally involves the direction of light energy through a lens, or "reticle," and onto the substrate. In conventional photolithographic processes, a photoresist material is first applied on a substrate layer to be etched. In the context of optical resists, the resist material is sensitive to radiation or "light energy," such as ultraviolet or laser sources. The resist material preferably defines a polymer that is tuned to respond to the specific wavelength of light used, or to different exposing sources.

[0006] After the resist is deposited onto the substrate, the light source is actuated to emit ultraviolet (UV) light or low X-ray light, for example, directed at the resist-covered substrate. The selected light source chemically alters the composition of the photoresist material. However, the photoresist layer is only selectively exposed. In this respect, a photomask, or "reticle," is positioned between the light source and the substrate being processed. The photomask is patterned to contain the desired configuration of features for the substrate. The patterned photomask allows light energy to pass therethrough in a precise pattern onto the substrate surface. The exposed underlying substrate material may then be etched to form patterned features in the substrate surface while the retained resist material remains as a protective coating for the unexposed underlying substrate material. In this manner, contacts, vias, or interconnects may be precisely formed.

[0007] Photoresist film may comprise various materials, such as silicon dioxide (SiO_2), silicon oxynitride (SiON), silicon nitride (Si_3N_4), and hafnium dioxide (HfO_2). Somewhat recently, an effective carbon-based film has been developed by Applied Materials, Inc. of Santa Clara, California. That film is known as Advanced Patterning Film™, or "APF." APF™ generally comprises films of SiON and amorphous carbon, or "α–carbon."

[0008] The carbon layer is generally deposited by plasma enhanced chemical vapor deposition (PECVD) of a gas mixture comprising a carbon source. The gas mixture may be formed from a carbon source that is a liquid precursor or a gaseous

precursor. Preferably, the carbon source is a gaseous hydrocarbon. For example, the carbon source may be propylene (C_3H_6). The injection of C_3H_6 is accompanied by the generation of an RF plasma within the process chamber. The gas mixture may further comprise a carrier gas, such as helium (He) or Argon (Ar). The carbonaceous layer may be deposited to a thickness of between about 100 Å and about 20,000 Å, depending upon the application.

[0009] The process of depositing a carbon-based (or "organic") film such as APF™ produces a carbon residue, particularly at high deposition rates, such as rates greater than 2,000 A/min. In this respect, carbon is deposited not only on the substrate, but on the internal chamber body, the substrate support, and various kit parts, e.g., liners and showerhead, as well. During subsequent depositions, the film on the walls of the chamber body and other parts can crack or peel, causing contaminant particles to fall onto the substrate. This, in turn, causes damage to resistors, transistor, and other IC devices on the substrate.

[0010] To reduce contamination of wafer features, the PECVD chamber must be periodically cleaned to remove particulates between depositions. Cleaning is generally done by passing an etch gas between substrate processing operations into the emptied chamber. The etching plasma may be a fluorine-containing gas such as nitrogen trifluoride. In the context of carbon-based deposition, an oxygen species that is reactive with the carbon film deposited on the chamber wall and the various kit parts, e.g., the heater, the showerhead, liners, etc. may be employed. This is known as a "dry clean" operation.

[0011] Dry cleaning of a deposition chamber is generally effective in cleaning the chamber walls in an organic deposition chamber. However, oxygen in its reactive state is short-lived, and quickly recombines to an inactive state. This means that the oxygen plasma is less effective in reaching areas of the chamber apart from the primary flow path of the injected gases, i.e., the annular pressure ring, the heater area, etc. Therefore, it is necessary for the operator to periodically stop the substrate processing process altogether, and to disassemble the deposition chamber for scrubbing. This is known as a "wet clean" process.

[0012] When PECVD deposition chambers are silane or TEOS based, the wet-clean intervention process is rarely needed. However, in known carbon-based PECVD deposition chambers, the wet-clean intervention is required after every few hundred substrate processing cycles. It has been observed by the inventors herein that the problem of carbon residue on various fixtures within a processing chamber and on chamber walls is exacerbated by the phenomenon of "parasitic pumping." This means that processing gases are accessing remote areas of the processing chamber, requiring periodic disassembling and scrubbing of chamber parts. This interruption of substrate processing represents an obstacle to throughput and profitability of the semiconductor fabrication process.

[0013] Therefore, it is desirable to have a deposition chamber that is constructed such that the frequency for wet-clean interventions is reduced. There is further a need for an improved process kit design that inhibits penetration of carbon and build-up of carbonaceous residue in areas that are difficult for etching plasma to effectively clean.

Summary of the Invention

[0014] The present invention provides a process kit for a semiconductor processing chamber. The processing chamber is a vacuum processing chamber that includes a chamber body defining an interior processing region. The process kit includes a pumping liner configured to be placed within the processing region of the processing chamber, and a C-channel liner configured to be placed along an outer diameter of the pumping liner. The pumping liner and the C-channel liner have interlocking features designed to inhibit parasitic pumping of processing or cleaning gases from the processing region.

[0015] In one embodiment, the pumping liner comprises a circumferential body, a plurality of pumping holes disposed along the pumping liner body, a shoulder circumferentially placed along an upper surface of the pumping liner body, and a lower lip disposed along a radial portion of a lower surface of the pumping liner body. In one embodiment, the C-channel liner comprises a circumferential body, an upper arm, a lower arm, a channel portion for receiving process gases, an upper lip circumferentially disposed along the upper arm, and a lower shoulder residing along

a radial portion of the lower arm. The upper lip of the C-channel liner is configured to interlock with the shoulder of the pumping liner, while the lower shoulder of the C-channel liner is configured to interlock with the lower lip of the pumping liner.

[0016] The invention further provides a semiconductor processing chamber having an interlocking process kit, such as the kit described above. In one arrangement, the chamber is a tandem processing chamber. The chamber may also include an upper pumping port liner in fluid communication with the channel portion of the C-channel liner.

Description of the Drawings

[0017] So that the manner in which the above recited features of the present invention can be understood in detail, a more particular description of embodiments of the invention may be had by reference to the appended drawings. It is to be noted, however, that the appended drawings illustrate only typical embodiments of this invention and are, therefore, not to be considered limiting of its scope.

[0018] Figure 1 provides a top view of an exemplary semiconductor processing system. The processing system includes pairs of deposition chambers that receive the process kits of the present invention.

[0019] Figure 2 provides a cross-sectional view of an illustrative deposition chamber for comparison. The chamber of Figure 2 is a twin or "tandem" chamber. However, it is understood that the process kits described herein may be used in a single chamber design.

[0020] Figure 3 provides a partial cross-sectional view of a typical chamber body. The chamber body is depicted in a schematic manner for the purpose of demonstrating gas flow paths. Arrows depict primary gas flow and parasitic gas flow paths within the chamber.

[0021] Figure 4 presents a perspective view of a portion of a deposition chamber. A chamber body is provided to define a substrate processing region, and for supporting various liners. A wafer slit valve is seen in the chamber body, providing a wafer pass-through slit.

[0022] Figure 5 shows a cutaway, perspective view of the illustrative deposition chamber of Figure 4. Visible in Figure 5 is a top liner, or "pumping liner," supported by a surrounding C-channel liner.

[0023] Figure 6 shows the chamber body of Figure 5, highlighting the two exposed areas from the cutaway view. These two cross-sectional areas are designated as area 6A and area 6B.

[0024] Figure 6A provides an enlarged view of cross-sectional area 6A from Figure 6. Similarly, Figure 6B provides an enlarged view of cross-sectional area 6B. The top liner and supporting C-channel liner are seen in each figure.

[0025] Figure 7 shows an exploded view of the chamber body portion of Figure 4. In this view, various liners from a process kit, in one embodiment, can be more clearly identified.

Description of Embodiments of the Invention

[0026] **Figure 1** provides a plan view of an exemplary semiconductor processing system **100**. The processing system **100** includes processing chambers **106** that will receive the process kits of the present invention, described below. The illustrative chambers **106** are in pairs to further increase processing throughput.

[0027] The system **100** generally includes multiple distinct regions. The first region is a front end staging area **102**. The front end staging area **102** supports wafer cassettes **109** pending processing. The wafer cassettes **109**, in turn, support substrates or wafers **113**. A front end wafer handler **118**, such as a robot, is mounted on a staging platform adjacent to wafer cassette turntables. Next, the system **100** includes a loadlock chamber **120**. Wafers **113** are loaded into and unloaded from the loadlock chamber **120**. Preferably, the front end wafer handler **118** includes a wafer mapping system to index the substrates **113** in each wafer cassette **109** in preparation for loading the substrates **113** into a loadlock cassette disposed in the loadlock chamber **120**. Next, a transfer chamber **130** is provided. The transfer chamber **130** houses a wafer handler **136** that handles substrates **113** received from the loadlock chamber **120**. The wafer handler **136** includes a robot assembly **138** mounted to the bottom of the transfer chamber **130**. The wafer

handler **136** delivers wafers through sealable passages **136**. Slit valve actuators **134** actuate sealing mechanisms for the passages **136**. The passages **136** mate with wafer passages **236** in process chambers **140** (shown in **Figure 2**) to allow entry of substrates **113** into the processing regions for positioning on a wafer heater pedestal (shown at **228** in **Figure 2**).

[0028] A back end **150** is provided for housing various support utilities (not shown) needed for operation of the system **100**. Examples of such utilities include a gas panel, a power distribution panel, and power generators. The system can be adapted to accommodate various processes and supporting chamber hardware such as CVD, PVD and etch. The embodiment described below will be directed to a system employing a 300 mm APF deposition chamber. However, it is to be understood that other processes and chamber configurations are contemplated by the present invention.

[0029] **Figure 2** presents a cross-sectional, schematic diagram of a deposition chamber **200** for comparison. The deposition chamber is a CVD chamber for depositing a carbon-based gaseous substance, such as a carbon-doped silicon oxide sublayer. This figure is based upon features of the Producer S® APF chamber currently manufactured by Applied Materials, Inc. The Producer® CVD chamber (200 mm or 300 mm) has two isolated processing regions that may be used to deposit carbon-doped silicon oxides and other materials. A chamber having two isolated processing regions is described in United States Patent No. 5,855,681, which is incorporated by reference herein.

[0030] The chamber **200** has a body **202** that defines an inner chamber area. Separate processing regions **218** and **220** are provided Each chamber **218, 220** has a pedestal **228** for supporting a substrate (not seen) within the chamber **200**. The pedestal **228** typically includes a heating element (not shown). Preferably, the pedestal **228** is movably disposed in each processing region **218, 220** by a stem **226** which extends through the bottom of the chamber body **202** where it is connected to a drive system **203**. Internally movable lift pins (not shown) are preferably provided in the pedestal **228** to engage a lower surface of the substrate. Preferably, a support ring (not shown) is also provided above the pedestal **228**. The support ring

may be part of a multi-component substrate support assembly that includes a cover ring and a capture ring. The lift pins act on the ring to receive a substrate before processing, or to lift the substrate after deposition for transfer to the next station.

[0031] Each of the processing regions **218, 220** also preferably includes a gas distribution assembly **208** disposed through a chamber lid **204** to deliver gases into the processing regions **218, 220**. The gas distribution assembly **208** of each processing region normally includes a gas inlet passage **240** which delivers gas into a shower head assembly **242**. The showerhead assembly **242** is comprised of an annular base plate **248** having a blocker plate **244** disposed intermediate a face plate **246**. The showerhead assembly **242** includes a plurality of nozzles (shown schematically at **248** in **Figure 3**) through which gaseous mixtures are injected during processing. The nozzles **248** direct gas, e.g. propylene and argon, downward over a substrate, thereby depositing an amorphous carbon film. An RF (radio frequency) feedthrough provides a bias potential to the showerhead assembly **242** to facilitate generation of a plasma between the face plate **246** of the showerhead assembly **242** and the heater pedestal **228**. During a plasma-enhanced chemical vapor deposition process, the pedestal **228** may serve as a cathode for generating the RF bias within the chamber walls **202**. The cathode is electrically coupled to an electrode power supply to generate a capacitive electric field in the deposition chamber **200**. Typically an RF voltage is applied to the cathode while the chamber body **202** is electrically grounded. Power applied to the pedestal **228** creates a substrate bias in the form of a negative voltage on the upper surface of the substrate. This negative voltage is used to attract ions from the plasma formed in the chamber **200** to the upper surface of the substrate. The capacitive electric field forms a bias which accelerates inductively formed plasma species toward the substrate to provide a more vertically oriented anisotropic filming of the substrate during deposition, and etching of the substrate during cleaning.

[0032] The gaseous hydrocarbon delivered through the showerhead assembly **242** is considered robust, and is able to flow throughout the chamber **200**. **Figure 3** presents a partial cross-sectional view of the chamber body **202** of **Figure 2**, in a schematic form. Arrows depict primary and parasitic gas flow paths within the chamber **200**. The primary gas flow path is indicated by arrows **Pr**, while the

parasitic gas flow path is indicated by arrows Pa. The primary gas flow path **Pr** is the preferred flow path, while the parasitic gas flow path **Pa** is undesirable. The parasitic gas flow **Pa** is able to contact various kit parts within the chamber **200**, and to leak into unsealed areas. As noted above, periodic wet cleaning of the deposition chamber **200** is needed in order to access and sufficiently clean carbonic residue from the various parts and unsealed areas within the chamber **200**.

[0033] The chamber of **Figure 3** is highly schematic. It will be understood by one of ordinary skill in the art from the drawing and from this disclosure that parasitic pumping may occur in gaps between the various liners and other hardware that make up a process kit for a processing chamber. Such areas susceptible to parasitic pumping include (1) the gap between a top liner and the faceplate; (2) the gap between a C-channel liner and the top liner; (3) the slit valve channel; (4) the gap between the C-channel liner and the middle liner at the slit valve tunnel; (5) the gap between the middle liner and the bottom liner; (6) the gap between a surrounding filler and the middle liner; and so forth.

[0034] **Figure 4** presents a perspective view of a portion of a deposition chamber **400**. The deposition chamber **400** includes a process kit **40** of the present invention, in one embodiment. A chamber body **402** is provided to define a substrate processing region **404**, and for supporting various liners of the process kit **40**. A wafer slit **406** is seen in the chamber body **402**, defining a wafer pass through slit. In this manner, a substrate may be selectively moved into and out of the chamber **400**. A substrate is not shown within the hollow chamber. The slit **406** is selectively opened and closed by a gate apparatus (not shown). The gate apparatus is supported by the chamber wall **402**. The gate isolates the chamber environment during substrate processing.

[0035] The chamber body **402** is preferably fabricated from an aluminum oxide or other ceramic compound. Ceramic material is preferred due to its low thermal conductivity properties. The chamber body **402** may be cylindrical or other shape. The exemplary body **402** of **Figure 4** has an outer polygonal profile, and a circular inner diameter. However, the present invention is not limited to any particular configuration or size of processing chamber.

[0036] As noted, the body **402** is configured to support a series of liners and other interchangeable processing parts. These processing parts are generally disposable, and come as part of a "process kit" **40** specific for a particular chamber application or configuration. A process kit may include a top pumping liner, a middle liner, a lower liner, a gas distribution plate, a gas diffuser plate, a heater, a shower head, or other parts. Certain liners may be formed integrally; however, it is preferred in some applications to provide separate liners that are stacked together to allow thermal expansion between the liners. **Figure 7** provides a perspective view of a process kit **40** in one embodiment. The liners and other equipment of the process kit **40** are shown exploded above a deposition chamber **400**. The chamber **400** of **Figure 7** will be discussed in greater detail below.

[0037] **Figure 5** shows a cutaway, perspective view of the illustrative deposition chamber **400** of **Figure 4**. The geometry of the chamber body **402** is more clearly seen, including side **408** and bottom **409** portions of the body **402**. An opening **405** is formed in the side portion **408** of the body **402**. The opening **405** serves as a channel for receiving process gasses during a deposition, etching or cleaning process.

[0038] A substrate is not shown within the hollow chamber **404**. However, it is understood that a substrate is supported within the hollow chamber **404** on a pedestal, such as pedestal **228** of **Figure 2**. The pedestal is supported by a shaft that extends through opening **407** in the bottom portion **409** of the body **402**. In addition, it is understood that a gas processing system (not shown in **FIG. 5**) is provided for the chamber **400**. An opening **478** is provided in the illustrative chamber **400** for receiving a gas conduit. The conduit delivers gas to gas box (seen at **472** in **Figure 7**). From there, gas is delivered into the chamber **404**.

[0039] Certain parts of a process kit **40** for a deposition chamber are visible in **Figures 4** and **5**. These include a top pumping liner **410**, a supporting C-channel liner **420**, a middle liner **440** and a bottom liner **450**. As noted, these liners **410**, **420**, **440** and **450** are shown and will be described in greater detail in connection with **Figure 7**, below. A seal member **427** is provided at an interface of the C-channel liner **420** with a pumping port liner **442**, and at an interface of the pumping liner **410**

with the pumping port liner **442**, as will be also shown and described in greater detail in connection with **Figure 6A**, below.

[0040] **Figure 6** shows another perspective view of the chamber body **402** of **Figure 5**. Reference numbers from **Figure 5** are, in some instances repeated. **Figure 6** is provided to highlight the two exposed areas from the cutaway view. These two cross-sectional areas are **area 6A** and **area 6B**. Features of the chamber **400** shown in **areas 6A** and **6B** are seen more clearly in the respective enlarged cross-sectional views of **Figure 6A** and **6B**. These features will also be described in detail below.

[0041] **Figure 7** provides an exploded view of a chamber body portion **400**. In this instance, the chamber body **400** represents a tandem processing chamber. An example is the Producer S chamber manufactured by Applied Materials, Inc. Various parts of a process kit **40** are seen arising from the processing area **404** on the right side of the body **402**.

[0042] The first item of equipment seen in the view of **Figure 7** is a top cover **470**. The top cover **470** is centrally located within the processing area **404**, and protrudes through the chamber lid (not seen). The top cover **470** serves as a plate to support certain gas delivery equipment. This equipment includes a gas box **472** which receives gas through a gas supply conduit (not seen). (The conduit is inserted through opening **478** in the bottom **409** of the chamber body **402**, as seen in **Figure 5**). The gas box **472** feeds gas into a gas input **476**. The gas input **476** defines an arm that extends over to the center of the top cover **470**. In this way, processing and cleaning gases may be introduced centrally into the processing area **404** above the substrate.

[0043] An RF power is supplied to the gas box **472**. This serves to generate plasma from the processing gases. A constant voltage gradient **474** is disposed between the gas box **472** and the gas input **476**. The constant voltage gradient **474**, or "CVG," controls the power level as the gas moves from the gas box **472** towards the grounded pedestal within the processing area **404**.

[0044] Immediately below the top cover **470** is a blocker plate **480**. The blocker plate **480** defines a plate concentrically placed below the top cover **470**. The blocker plate **480** includes a plurality of bolt holes **482**. The bolt holes **482** serve as a through-opening through which screws or other connectors may be placed for securing the blocker plate **480** to the top cover **470**. A spacing is selected between the blocker plate **480** and the top cover **470**. Gas is distributed in this spacing during processing, and then delivered through the blocker plate **480** by means of a plurality of perforations **484**. In this way, processing gases may be evenly delivered into the processing area **404** of the chamber **400**. The blocker plate **480** also provides a high pressure drop for gases as they are diffused.

[0045] Below the blocker plate **480** is a shower head **490**. The shower head **490** is concentrically placed below the top cover **470**. The shower head **490** includes a plurality of nozzles (not seen) for directing gases downward onto the substrate (not seen). A face plate **496** and isolator ring **498** are secured to the shower head **490**. The isolator ring **490** electrically isolates the shower head **490** from the chamber body **402**. The isolator ring **498** is preferably fabricated from a smooth and relatively heat resistant material, such as Teflon or ceramic.

[0046] Disposed below the shower head **490** is a top liner, or "pumping liner" **410**. In the embodiment of **Figure 7**, the pumping liner **410** defines a circumferential body having a plurality of pumping holes **412** disposed there around. In the arrangement of **Figure 7**, the pumping poles **412** are equidistantly spaced apart. During a wafer processing process, a vacuum is pulled from a back side of the top liner **410**, drawing gases through the pumping holes **412** and into a channel area **422** (seen more clearly in **FIGS. 6A** and **6B**). The pumping holes **412** provide the primary flow path for processing gases, as depicted in the schematic view of **Figure 3**.

[0047] Turning to the enlarged cross sectional views of **Figures 6A** and **6B**, features of the top liner **410** can be more readily seen. **Figure 6A** provides an enlarged view of cross-sectional **area 6A** from **Figure 6**. Similarly, **Figure 6B** provides an enlarged view of **area 6B** from **Figure 6**. The pumping liner **410** is visible in each of these enlarged figures.

[0048] The pumping liner **410** defines a circumferential body **410'**, and serves to hold a plurality of pumping ports **412**. In the arrangement of **Figure 7**, the pumping liner **410** includes an upper lip **414** on an upper surface area, and a lower shoulder **416** along a lower surface area. In one aspect, the upper lip **414** extends outwardly from the radius of the top liner **410**, while the lower shoulder **416** extends radially inward. The upper lip **414** is circumferentially disposed. For this reason, the upper lip **414** is visible in both **Figure 6A** and **Figure 6B**. However, the lower shoulder **416** does not circumferentially encompass the top liner **410**, but is left open in the area of an upper pumping port liner **442**.

[0049] Returning to **Figure 4**, the chamber **400** next comprises a circumferential channel liner **420**. In the arrangement of **Figure 7**, the liner **420** has a profile of an inverted "C". In addition, the liner **420** includes a channel portion **422**. For these reasons, the liner **420** is designated as a "C-channel liner." The inverted "C" configuration is seen more clearly in the enlarged cross sectional view of **Figure 6B**.

[0050] Looking again at **Figure 6B**, the C-channel liner **420** has an upper arm **421**, a lower arm **423**, and an intermediate inner body **422**. The upper arm **421** has an upper shoulder **424** formed therein. The upper shoulder **424** is configured to receive the upper lip **414** of the pumping liner **410**. At the same time, the lower arm **423** is configured to receive the lower shoulder **416** of the top liner **410**. This interlocking arrangement between the top liner **410** and the C-channel liner **420** provides a circuitous interface that substantially reduces unwanted parasitic pumping. In this way, as gases are exhausted from the processing area **404** of the chamber **400** and through the pumping holes **412** of the pumping liner **410**, gas is preferentially evacuated through the channel portion **422** of the C-channel liner **420**, and is not lost at the interfaces between the top liner **410** and the C-channel liner **420**.

[0051] It is to be noted that the interlocking relationship between the upper lip **414** of the pumping liner **410** and the upper shoulder **424** of the C-channel liner **420** is illustrative only. Likewise, the interlocking relationship between the lower shoulder **416** of the pumping liner **410** and the lower lip **426** of the C-channel liner **420** is illustrative only. In this respect, it is within the scope of the present invention to

include any interlocking arrangement between the pumping liner **410** and the C-channel liner **420** to inhibit parasitic pumping of processing, cleaning or etch gases. For example, and not by way of limitation, both the upper lip **414** and the lower shoulder **416** of the pumping liner **410** could be configured to extend outwardly from the radius of the top liner **410**. In such an arrangement, the lower lip **426** of the C-channel liner **420** would be reconfigured to interlock with the lower shoulder **416** of the pumping liner **410**.

[0052] In the process kit **40** arrangement of **Figures 6A**, **6B** and **7**, the upper shoulder **424** is circumferentially disposed along the upper arm **421**. For this reason, the upper shoulder **424** is visible in both **Figure 6A** and **Figure 6B**. However, the lower lip **426** does not circumferentially encompass the C-channel liner **420**, but is also left open in the area of the upper pumping port liner **442**. Thus, a radial portion is left open to form a pumping port liner opening **429**.

[0053] As indicated from the cutaway perspective view provided in **Figure 6, areas 6A** and **6B** show opposite ends of the chamber **400**. The cutaway end from **area 6A** includes gas exhaust ports, referred to as "pumping port liners" **442**, **444**. An upper pumping port liner **442** is provided below the channel portion **422** of the C-channel liner **420**. A lower pumping port liner **444** is then provided in fluid communication with the upper port liner **442**. Gas may then be exhausted out of the lower pumping port liner **444** and away from the processing chamber **400** by means of an exhaust system.

[0054] To further limit parasitic pumping at the area of the pumping port liners **442**, **444**, a seal member **427** is provided at the interface between the C-channel liner **420** and the upper pumping port liner **442**, and at the interface between the top liner **410** and the upper pumping port liner **442**. The seal member is visible at **427** in both **Figure 7** and **Figure 6B**. Preferably, the seal member **427** defines a circular ring that encompasses the upper pumping port liner **442**. The seal member **427** is preferably fabricated from a Teflon material or otherwise includes a highly polished surface. The seal **427** further enables the C-channel liner **420** to interlock with the pumping ports **442**, **444** and to limit gas leakage.

[0055] Referring back to **Figure 7**, a middle liner **440** is next disposed below the C-channel liner **420**. The middle liner **440** resides in the process area **404** at the level of the slit **432**. It can be seen from **Figur 7** that the middle liner **440** is a C-shaped liner, and is not circular. The open area in the middle liner **440** is configured to receive wafers as they are imported into the process chamber **400**. The middle liner **440** can be partially seen in both **Figure 6A** and **Figure 6B**, residing below the C-channel liner **420** and the top liner **410**.

[0056] Also visible in **Figure 7** is a bottom liner **450**. In the arrangement of **Figure 7**, the bottom liner **450** is disposed in the chamber **400** below the middle liner **440**. The bottom liner **450** resides between the middle liner **440** and the bottom surface **409** of the chamber **400**.

[0057] It should be noted at this point that it is within the scope of the present invention to utilize a process kit wherein selected liners are integral to one another. For example, the middle liner **440** could be integrally formed with the bottom liner **450**. Similarly, the top liner **410** could be integral to the C-channel liner **420**. However, it again is preferred that the various liners, e.g., liners **410**, **420**, **440** and **450** be separate. This substantially reduces the risk of cracking induced by thermal expansion during heating processes. The employment of a separate but interlocking pumping liner **410** and C-channel liner **420** provides an improved and novel arrangement for a process chamber process kit.

[0058] Additional process kit items seen in **Figure 7** include a filler member **430** and a pressure equalization port liner **436**. The filler member **430** is placed around the middle **440** and bottom **450** liners in order to fill space between the outer diameters of these liners **440**, **450** and the surrounding chamber body **402**. The presence of the filler member **430** aides in channeling the collection of carbon residues behind the liners **440**, **450** by keeping residues from forming behind the liners **440**, **450**.

[0059] It is noted that the filler member **430**, like the middle liner **440**, is not completely circumferential. In this respect, an open portion is retained in the filler member **430** to provide fluid communication between the two process chambers **404**. The pressure equalization port liner **436** controls the fluid communication

between the two process areas **404** by defining a sized orifice. The presence of the pressure equalization port liner **436** insures that pressures between the two process areas **404** remain the same.

[0060] It is also noted at this point that the filler member **430**, the pressure equalization port liner **436**, and the upper **442** and lower **444** pumping port liners are preferably coated with a highly smoothed material. An example is a shiny aluminum coating. Other materials provided with a very smooth surface, e.g., less than 15 Ar help reduce deposition accumulating on the surfaces. Such smooth materials may be polished aluminum, polymer coating, Teflon, ceramics and quartz.

[0061] To further aide in the reduction of deposition on chamber parts, a slit valve liner **434** is provided along the slit **432**. The slit liner **434** is likewise preferably fabricated from a highly smoothed material such as those mentioned above.

[0062] It is preferred that during a deposition or etching process, the processing areas **404** be heated. To this end, a heater is provided with the pedestal for supporting wafers. A heater pedestal is seen at **462** in the chamber arrangement **400** of **Figure 7**. It is particularly preferred that the heater be actuated to temperatures in excess of 110° C during a plasma cleaning process. Alternatively, it is possible to use ozone as the cleaning gas, as ozone does not require plasma to disassociate. In instances where ozone is not used, it is particularly desirable to heat the chamber body, thereby increasing the cleaning rate.

[0063] Referring again to **Figure 7**, a pedestal assembly **460** is provided. The pedestal assembly **460** serves to support a substrate during processing. The pedestal assembly **460** includes not only the heater plate **462**, but also a shaft **468**, a pin lift **464** and a lift hoop **466** disposed there around. The pin lift **464** and lift hoop **466** aide in selectively raising the wafer above the heater plate **462**. Pin holes **467** are disposed within the heater plate **462** to receive lift pins (not shown).

[0064] It is understood that the AFP™ chamber **400** of **Figure 7** is illustrative, and that the improvements of the present invention are viable in any deposition chamber capable of performing PECVD. Thus, other embodiments of the inventions may be provided. For example, the pumping liner **410** may have an inner diameter

that is smaller than the inner diameter of the C-channel liner **420**. This reduced dimension for the top pumping liner **410** serves to reduce the inner diameter of the pumping port **405**, thereby increasing velocity of gases moving out of the inner chamber **404** and through the pumping port **405**. Increased gas velocity is desirable, as it reduces opportunities for carbonaceous residue buildup on chamber surfaces. It is also desirable that the liners be fabricated from a material having a highly smooth surface. This serves to reduce amorphous carbon deposition from accumulating on the surface. Examples of such material again include polished aluminum, polymer coating, Teflon, ceramics, and quartz.

[0065] It is also noted that carbon builds up on colder surfaces faster than on warmer surfaces. Because of this phenomenon, carbon tends to preferentially build up on the pumping system associated with the deposition chamber. The pumping systems are preferably heated to a temperature greater than 80° C to reduce preferential build-up. Alternatively, or in addition, a cold trap can be integrated into the pumping system to collect unreacted carbon by-product. The cold trap can be cleaned or replaced at regular maintenance intervals.

[0066] While the foregoing is directed to embodiments of the present invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof. For example, one embodiment of a process kit for a vacuum processing chamber is provided, comprising a circumferential pumping liner configured to be placed within the processing region of a processing chamber, and a circumferential C-channel liner configured to be placed along an outer diameter of the pumping liner. The pumping liner may include a circumferential body having an upper surface and a lower surface, and a plurality of pumping holes disposed along the body. The C-channel may comprise a circumferential body portion having an upper surface and lower surface; a circumferential upper arm disposed proximate the upper surface of the body portion of the C-channel liner; a lower arm disposed around a selected radial portion of the body portion of the C-channel liner, the lower arm being along a bottom end of the body portion of the C-channel liner; and a channel portion in the C-channel liner defined between the body portion, the upper arm, the lower arm and an outer diameter of the pumping liner. An upper interlocking feature is provided between the upper surface of the pumping liner and

the upper arm of the C-channel liner. Similarly, a lower interlocking feature is provided between the lower surface of the pumping liner and the lower surface of the C-channel liner. The upper and lower interlocking features serve to inhibit parasitic pumping within the processing region during processing of a wafer.

[0067] In one embodiment, the process kit is placed in a process chamber that includes a pumping port liner that is in fluid communication with a pumping port liner opening of the C-channel liner.